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LIQUID CRYSTAL DISPLAY, METHOD FOR MANUFACTURING THE SAME AND EQUIPMENT APPLYING IMAGE DISPLAY

[Abstract]

PROBLEM TO BE SOLVED: To improve the degree of contact of a columnar resin pattern to a substrate and to prevent short circuiting between upper and lower substrates.

SOLUTION: A color filter pattern 5 is formed on a TFT array substrate 13, and a switching active element 4 is brought into contact with a pixel electrode disposed on the color filter pattern 5 through a contact hole 12. In this structure, a columnar

resin pattern 17 for forming a panel gap is formed on the contact hole 12 by using resin having conductivity, the upper face of the columnar resin pattern 17 is covered with an insulating coating, and the pixel electrode is formed, in contact with the columnar resin pattern 17. As a result of this method, the pixel electrode can be formed after the columnar resin pattern 17 having conductivity is formed on the contact hole part, and this prevents peeling of the columnar resin pattern 17 and improves the adhesion degree to the substrate.

[Claim(s)]

[Claim 1] A LCD apparatus of TFT array type, wherein a resin layer is formed on a TFT array substrate on which a switching active element for driving a pixel electrode is formed, the switching active element are contacted to a contact hole formed on the resin layer with the contact hole formed on the resin layer being sandwiched therebetween, liquid crystal is injected into a panel gap between the TFT array substrate and an opposing facing the TFT array substrate, and the panel gap is sealed, is characterized in that the cylinder-shaped resin pattern having conductivity for forming the panel gap is formed on the contact hole, and the pixel electrode is formed to be in contact with the cylinder-shaped resin pattern.

[Claim 2] The LCD apparatus of TFT array type of Claim 1, wherein an opposing electrode is formed on the opposing substrate and a surface of the cylinder-shaped resin pattern is coated by insulating, thereby insulating the opposing electrode.

[Claim 3] The LCD apparatus of TFT array type of Claim 2, wherein the resin layer is a color filter pattern, and a surface of the cylinder-shaped resin pattern is covered with a plurality of color layers of monochrome for forming a color filter pattern.

[Claim 4] The LCD apparatus of TFT array type of Claim 3, wherein the lower limit of volume specific resistance value for forming the color filter pattern is 108Ω · cm.

[Claim 5] The LCD apparatus of TFT array type of Claim 1, wherein the pixel electrode is not superimposed on the surface of the cylinder-shaped resin pattern and is not superimposed on the side of the cylinder-shaped resin pattern.

[Claim 6] The LCD apparatus of TFT array type of Claim 1, wherein the lower limit of (the diameter of bottom side of the cylinder-shaped resin pattern, or the distance of diagonal line) - (the diameter of a surface of the cylinder-shaped resin pattern, or the distance of diagonal line) is 5 μm.

[Claim 7] The LCD apparatus of TFT array type as set forth in any one of Claims 1 to 5, wherein an orientation process is performed by optical orientation.

[Claim 8] A manufacturing method of LCD apparatus is characterized in that a resin layer is formed on a TFT array substrate on which a switching active element for driving a pixel electrode is formed, a panel gap between the TFT array substrate and another TFT array substrate facing the other is formed as a resin having conductivity on the contact hole formed on the resin layer, a surface of the cylinder-shaped resin pattern is coated by insulating, a pixel electrode is formed, and the

switching active element and the pixel electrode are in contact with the cylinder-shaped resin pattern is formed therebetween.

[Claim 9] A manufacturing method of a LCD apparatus of a color filter on TFT array type, wherein a color filter pattern is formed on a TFT array substrate on which a switching active element for driving a pixel electrode is formed, and a pixel electrode is formed on the color filter pattern, comprising:

a step for forming a cylinder-shaped resin pattern for forming a panel gap between the TFT array substrate and another TFT array substrate facing the other TFT array substrate as a resin having conductivity, on the contact portion between the switching active element and the pixel electrode,

a step for forming a matrix pattern of an insulating shading resin so that it is superimposed on the surface of the cylinder-shaped resin pattern and is not superimposed on the side of the cylinder-shaped resin pattern,

a step for forming a color filter pattern by supplying coloring resist liquid to the portions except said matrix pattern, and

a step for contacting the switching active element and the pixel electrode with the cylinder-shaped resin pattern being formed therebetween.

[Claim 10] The manufacturing method of LCD apparatus of Claim 9, wherein

the supplying method of coloring resist liquid is a dropping by a syringe.

[Claim 11] The manufacturing method of LCD apparatus of Claim 9, wherein the supplying method of coloring resist liquid is an injection of liquid dropping.

[Claim 12] The manufacturing method of LCD apparatus of Claim 9, wherein the relationship of (the layer thickness of an insulating shading cylinder-shaped resin pattern) < (the layer thickness of the cylinder-shaped resin pattern) is satisfied.

[Claim 13] The manufacturing method of LCD apparatus of Claim 9, wherein the insulating shading cylinder-shaped resin pattern covers the switching active element on the TFT array substrate.

[Claim 14] The manufacturing method of LCD apparatus of Claim 9, wherein the lower limit of volume specific resistance value of the insulating shading cylinder-shaped resin pattern is 108Ω/cm.

[Claim 15] The manufacturing method of LCD apparatus of Claim 9, wherein the lower limit of OD value of the insulating shading cylinder-shaped resin pattern is above 2.0.

[Claim 16] The manufacturing method of LCD apparatus of Claim 9, wherein the pixel electrode is not superimposed on the surface of the cylinder-shaped resin

pattern and is not superimposed on the side of the cylinder-shaped resin pattern.

[Claim 17] An image display application device having a LCD apparatus set forth in any one of Claims 1 to 7.

[Title of the Invention]

LCD APPARATUS AND MANUFACTURING METHOD THEREOF, AND IMAGE DISPLAY APPLICATION DEVICE

[Detailed Description of the Invention]

[Field of the Invention]

The present invention is related to a LCD apparatus and manufacturing method thereof, and an image display application device.

[Description of the Prior Art]

A LCD apparatus is a major display device, and in particular is used widely in the fields in which a small size and a light weight are required. As is shown in FIG. 5, a LCD apparatus is formed by sealing the liquid crystal 8 between a color filter substrate 10 on which a color filter pattern 5 and a black matrix 6 are formed, and an array substrate 11 on which a switching active element 4 for driving a pixel electrode is formed. In Fig. 5, 1, 1' is a glass substrate, 2, 2' is a transparent electrode, 3, 3' is an orientation layer, 7 is a spacer and 9 is seal member.

[Means for Solving the Problem]

Recently, as the liquid crystal is being applied to the fields using a

conventional CRT, that is, the devices such as a large monitor, TV, and so forth, performance improvement of a LCD apparatus are being demanded more and more. Especially, a medical application such as X-ray photo display, application of the liquid crystal panel in Internet commercial transactions are being progressed and a high quality LCD panel with high brightness and high precision in which there are no non-uniformity of display has been demanded. But, a conventional LCD panel has a shortcoming that high brightness and high precision can not be compatible because of shading created due to a black matrix formed on the color filter. Further, sufficient performance can not be exhibited in said applications since the non-uniform display is generated since the beads spacer used for panel gap control infiltrates into a color filter layer.

Under these circumstances, an attempt is being made to form a flat resin layer, and a color filter pattern on a TFT array substrate on which a switching active element for driving a pixel electrode is formed. Further, a brisk attempt is being made to form a cylinder-shaped resin pattern for forming a panel gap in advance on an opposing substrate such as a TFT array substrate on which a switching active element for driving a pixel electrode, or a color filter substrate.

But, in the panel formed by combining these two technology, it is proved that fine non-uniformity of display is generated.

As a result of reviewing in order to solve this problem, it is turned out that non-uniformity of display is generated due to following reasons.

That problem is due to non-uniformity of a gap created by peeling off of a cylinder-shaped resin pattern .

Accordingly, the object of the present invention is to provide a LCD apparatus and manufacturing method thereof, and an image display application device which improves adhesion of a cylinder-shaped resin pattern, prevents short problems between upper and lower substrates in case of bonding, and securing conduction state between a switching active element and a pixel electrode.

In order to solve above-mentioned problems, in a LCD apparatus set forth in the claim 1, wherein a resin layer is formed on a TFT array substrate on which a switching active element for driving a pixel electrode, the switching active element are contacted to a contact hole formed on the resin layer with the contact hole formed on the resin layer being sandwiched therebetween, liquid crystal is injected into a panel gap between the TFT array substrate and an opposing facing the TFT array substrate, and the panel gap is sealed; is characterized in that the cylinder-shaped resin pattern having conductivity for forming the panel gap is formed on the contact hole, and the pixel electrode is formed is in contact with the cylinder-shaped resin pattern.

In this way, since the cylinder-shaped resin pattern having conductivity for forming the panel gap is formed on the contact hole, and the pixel electrode is formed is in contact with the cylinder-shaped resin pattern, it is possible to form a pixel electrode after forming a cylinder-shaped resin pattern having conductivity around the contact hole. Consequently, the adhesion of the cylinder-shaped resin pattern is improved by preventing peeling off of the cylinder-shaped resin pattern, the contact problems between a switching active element and a pixel electrode are reduced, surface faulting of a substrate is reduced and disturbance of liquid crystal orientation due to faulting is prevented.

A LCD apparatus of TFT array type set forth in the claim 2, in the claim 1, an opposing electrode is formed on the opposing substrate, and a surface of the cylinder-shaped resin pattern is coated by insulating, thereby insulating the opposing electrode.

In this way, since an opposing electrode is formed on the opposing substrate, and a surface of the cylinder-shaped resin pattern is coated by insulating, thereby insulating the opposing electrode, it is possible to suppress the short problems between upper and lower substrates when a panel bonding by covering the surface of the cylinder-shaped resin pattern having conductivity with a resin layer having no conductivity.

A LCD apparatus of TFT array type set forth in the claim 3, in the claim 2, the resin layer is a color filter pattern, and a surface of the cylinder-shaped resin pattern is covered with a plurality of color layers of monochrome forming a color filter pattern.

In this way, since the resin layer is a color filter pattern, and a surface of the cylinder-shaped resin pattern is covered with a plurality of color layers of monochrome for forming a color filter pattern, it is possible to suppress the short problems between upper and lower substrates, and exhibit more excellent display performances.

A LCD apparatus of TFT array type set forth in the claim 4, in the claim 3, the lower limit of volume specific resistance value for forming the color filter pattern is 108Ω/cm. In this way, since the lower limit of volume specific resistance value for forming the color filter pattern is 108Ω/cm, it is possible to suppress the short problems between upper and lower substrates, and exhibit more excellent display performances.

A LCD apparatus of TFT array type set forth in the claim 5, in the claim 1, the pixel electrode is not superimposed on the surface of the cylinder-shaped resin pattern and is not superimposed on the side of the cylinder-shaped resin pattern. In this way, since the pixel electrode is not superimposed on the surface of the

cylinder-shaped resin pattern and is not superimposed on the side of the cylinder-shaped resin pattern, to suppress the short problems between upper and lower substrates, and thereby enabling the switching active element and the pixel electrode to be in conduction state.

A LCD apparatus of TFT array type set forth in the claim 6, in the claim 1, the lower limit of (a diameter of bottom side of the cylinder-shaped resin pattern, or a distance of a diagonal line) - (a diameter of a surface of the cylinder-shaped resin pattern, or distance of diagonal line) is 5 μm. In this way, since the lower limit of (the diameter of bottom side of the cylinder-shaped resin pattern, or distance of diagonal line) - (the diameter of a surface of the cylinder-shaped resin pattern, or distance of diagonal line) is 5 μm, it enables the switching active element and the pixel electrode to be in conduction state.

A LCD apparatus of TFT array type set forth in the claim 7, in any one of the claim 1-6, orientation process is performed by optical orientation. In this way, orientation process performed by optical orientation can be applied to LCD apparatus.

A manufacturing method of LCD apparatus set forth in the claim 8 is characterized in that a resin layer is formed on a TFT array substrate on which a switching active element for driving a pixel electrode is formed, a panel gap

between the TFT array substrate and an opposing facing the TFT array substrate is formed as a resin having conductivity on the contact hole formed on the resin layer, a surface of the cylinder-shaped resin pattern is coated by insulating, a pixel electrode is formed, and the switching active element and the pixel electrode are contacted with the cylinder-shaped resin pattern is sandwiched therebetween.

In this way, since a panel gap between the TFT array substrate and an opposing facing the TFT array substrate is formed as a resin having conductivity on the contact hole formed on the resin layer, a surface of the cylinder-shaped resin pattern is coated by insulating, a pixel electrode is formed, and the switching active element and the pixel electrode are contacted with the cylinder-shaped resin pattern is sandwiched therebetween, the adhesion of the cylinder-shaped resin pattern is improved by preventing peeling off of the cylinder-shaped resin pattern, the contact problems between a switching active element and a pixel electrode are reduced, surface faulting of a substrate is reduced and disturbance of liquid crystal orientation due to faulting is prevented. In addition, it is possible to suppress the short problems between upper and lower substrates when a panel bonding by covering the surface of the cylinder-shaped resin pattern having conductivity with a resin layer having no conductivity.

A manufacturing method of a LCD apparatus set for th in the claim 9 is a

manufacturing method of a LCD apparatus of a color filter on TFT array type, wherein a color filter pattern is formed on a TFT array substrate on which a switching active element for driving a pixel electrode is formed, and a pixel electrode is formed on the color filter pattern, comprises a step for forming a cylinder-shaped resin pattern for forming a panel gap between the TFT array substrate and an opposing facing the TFT array substrate as a resin having conductivity, on the contact portion between the switching active element and the pixel electrode, a step for a matrix pattern of an insulating shading resin so that it is superimposed on the surface of the cylinder-shaped resin pattern and is not superimposed on the side of the cylinder-shaped resin pattern, a step for forming a color filter pattern by supplying coloring resist liquid to the portions except said matrix pattern, and a step for contacting the switching active element and the pixel electrode with the cylinder-shaped resin pattern being sandwiched therebetween.

In this way, a conduction between the switching active element and the pixel electrode can be realized by forming a conducting cylinder-shaped resin pattern having conductivity and functioning as a spacer for controlling on the drain electrode of a switching element. A matrix pattern for preventing a mixed color of adjacent color filter pattern is formed by an insulating shading resin layer. On the other hand, the pattern shape of the insulating shading resin is designed to be superimposed on the upper side of a conducting cylinder-shaped resin pattern, and

thereby prevention of a mixed color of a color filter pattern, prevention of a short between upper and lower substrates when bonding the panels, and shading protection of the switching active transistor can be realized. Therefore, it is possible to produce LCD apparatus of a color filter on TFT array type.

A manufacturing method of LCD apparatus set forth in the claim 10, in the claim 9, the supplying method of coloring resist liquid is dropping method by a syringe. In this way, since the supplying method of coloring resist liquid is dropping method by a syringe, it is possible to form a color filter on a TFT array substrate with high efficiency.

A manufacturing method of LCD apparatus set forth in the claim 11, in the claim 9, the supplying method of coloring resist liquid is an injection by liquid dropping. In this way, since the supplying method of coloring resist liquid is an injection by liquid dropping, it is possible to form a color filter on a TFT array substrate with high efficiency. In addition, in injection of coloring resist liquid dropping, a printer head can be used.

A manufacturing method of LCD apparatus set forth in the claim 12, in the claim 9, the relationship, (the layer thickness of an insulating shading cylinder-shaped resin pattern) < (the layer thickness of the cylinder-shaped resin pattern) is satisfied. In this way, since the relationship, (the layer thickness of an insulating

shading cylinder-shaped resin pattern) < (the layer thickness of the cylinder-shaped resin pattern) is satisfied, it is possible to contact between the switching active element and the pixel electrode.

A manufacturing method of LCD apparatus set forth in the claim 13, in the claim 9, the insulating shading cylinder-shaped resin pattern covers the switching active element on the TFT array substrate. In this way, since the insulating shading cylinder-shaped resin pattern covers the switching active element on the TFT array substrate, shading protection of a transistor can be realized.

A manufacturing method of LCD apparatus set forth in the claim 14, the lower limit of volume specific resistance value of the insulating shading cylinder-shaped resin pattern is 108Ω/cm. In the claim 9, since the lower limit of volume specific resistance value of the insulating shading cylinder-shaped resin pattern is 108Ω/cm, the short problems between the electrodes can be prevented.

A manufacturing method of LCD apparatus set forth in the claim 15, in the claim 9, the lower limit of OD volume specific resistance value of the insulating shading cylinder-shaped resin pattern is above 2.0. In this way, since the lower limit of OD value of the insulating shading cylinder-shaped resin pattern is above 2.0, shading protection of a transistor can be realized. OD value is an abbreviation of optical density, and can be also called as optical concentration. That is, it means

the transmissivity of light against a black portion such as a black matrix. As the value is getting larger and larger, the light can not penetrate.

A manufacturing method of LCD apparatus set forth in the claim 16, tin the claim 9, the pixel electrode is not superimposed on the surface of the cylinder-shaped resin pattern and is not superimposed on the side of the cylinder-shaped resin pattern. In this way, since the pixel electrode is not superimposed on the surface of the cylinder-shaped resin pattern and is not superimposed on the side of the cylinder-shaped resin pattern, a short problem between opposing substrates can be prevented.

An image display application device set forth in the claim 17 has a LCD apparatus described in any one of the claim 1-7. In this way, since a LCD apparatus including the structure described as above is provided, the LCD apparatus is suitable for an image display application device which requires high brightness, high precision and uniformity of display.

The first embodiment of the present invention will be explained by referring to FIG. 1 and FIG. 2. FIG. 1 is a cross-sectional diagram of LCD apparatus according to the first embodiment of the present invention.

As is shown in FIG. 1, in this LCD apparatus, a switching active element 4 for driving a pixel electrode is formed, orientation process is applied to a substrate

14 by a color filter on-array substrate 13 on which a color filter pattern(resin layer) 5 and a black matrix 6 are formed, a cell gap is controlled by a cylinder-shaped resin pattern 17 arranged with a predetermined density, two substrates subject to the orientation process are bonded with a sealing member 9, and liquid crystal 8 is sealed with a sealing member 9.

Further, the switching active element 4 are contacted to a pixel electrode(a transparent electrode 2) arranged on the color filter pattern 5 with a contact hole 12 formed on the color filter pattern 5 being sandwiched therebetween. A cylinder-shaped resin pattern 17 forming a panel gap between the TFT array substrate 13 and an opposing substrate 14 facing the TFT array substrate is formed as a resin having conductivity on the contact hole 12, a surface of the cylinder-shaped resin pattern 17 is coated by insulating, and the pixel electrode are contacted with the cylinder-shaped resin pattern 17. In this case, since a cylinder-shaped resin pattern 17 is formed on the contact hole 12, a plurality of color layers of monochrome for forming a color filter pattern 5 are formed on a surface of the cylinder-shaped resin pattern 17. In the drawing, 2, 2' is a transparent electrode, and some parts of them are superimposed on the side of the cylinder-shaped resin pattern 17. 1, 1' is a glass substrate, and 3, 3' is an orientation layer.

Further, (the volume specific resistance value of the cylinder-shaped resin

pattern for forming a color filter pattern) is above 108Ω/cm. (The diameter of bottom side of the cylinder-shaped resin pattern, or distance of diagonal line) - (the diameter of a surface of the cylinder-shaped resin pattern, or distance of diagonal line) is above 5 μm. The bottom of the cylinder-shaped resin pattern 17 means the bottom of a cone on the contact hole 17.

Next, a manufacturing method of a LCD apparatus will be explained.

A LCD apparatus of TFT array type, a color filter patter 5 is formed on a TFT array substrate 13. A cylinder-shaped resin pattern 17 is formed as a conducting resin on the contact hole 12 formed on the color filter pattern 5. A surface of the cylinder-shaped resin pattern 17 is coated by insulating. A pixel electrode 2 is formed on a color filter pattern 5, the pixel electrode 2 and a switching active element 4 are contacted with the cylinder-shaped resin pattern 17 being sandwiched therebetween.

At this time, the fact that (a lower bottom of the cylinder-shaped resin pattern) - (un upper bottom) is set to above 5μm is explained as follows. FIG. 2(a) is a plane drawing of the cylinder-shaped resin pattern, (b) is a cross-sectional drawing. In case that (a lower bottom of the cylinder-shaped resin pattern) - (un upper bottom) is set to above 5μm, the pixel electrode 12 is not superimposed on the cylinder-shaped resin pattern 17, and is superimposed on the side of the resin

patter due to a positional difference created when forming an ITO pattern. Since it is necessary to provide a margin width corresponding to the positional difference, 5μm is designated. That is, a layer forming sequence is composed of a step for forming a cylinder-shaped resin pattern 17, a step for forming a color filter pattern(an insulating pattern), and a step for forming a transparent electrode pattern sequentially, as described above. Further, the design conditions of a pixel electrode pattern are as follows. That is, the pattern is designed to be superimposed on the side of a cylinder-shaped resin pattern 17 to secure conductivity, and is designed not to be superimposed on the color filter pattern(insulating coat) for covering the cylinder-shaped resin pattern 17 to prevent a short between an opposing panel and the pattern when forming a panel.

Accordingly, the fact that (the diameter of bottom side of the cylinder-shaped resin pattern, or distance of diagonal line) - (the diameter of a surface of the cylinder-shaped resin pattern, or distance of diagonal line) is above 5 μm. is as follows.

The position precision when forming a pattern the design dimension ± 1μm(A limit of ITO patterning precision) is taken into consideration. In connection the design pattern, a positional alignment margin of ± 2μm is required. Therefore, if the difference between the upper and lower bottom of the cylinder-shaped resin

pattern 17 is not 5μm, it is impossible to design an ITO pattern.

The second embodiment of the present invention will be explained with referring to FIG. 3 and FIG. 4.

FIG. 3 is a cross-section of one example of a LCD apparatus according to the second embodiment of the present invention. An orientation substrate 14 is processed by orientation process on a color filter on-array substrate on 13 of TFT array substrate which a color filter pattern 5 and a black matrix 6 are formed. A cell gap is controlled by a cylinder-shaped resin pattern 17 arranged with a predetermined density, two substrates subject to the orientation process are bonded with a sealing member 9, and liquid crystal 8 is sealed with a sealing member 9. A cylinder-shaped resin pattern 17 is formed on the drain electrode 12, a black matrix pattern is formed on the surface. 2, 2' in the drawing are a transparent electrode which is formed to be superimposed on the cylinder-shaped resin pattern 17.

FIG. 4 is a process flow of manufacturing method of a LCD apparatus according to the second embodiment of the present invention. A conducting cylinder-shaped resin pattern 17 is formed on a drain electrode of TFT substrate 15 (FIG 4(a)). Then, A black matrix pattern is formed. At this time, some parts of the pattern 6 is designed to be superimposed on the cylinder-shaped resin pattern 17

(FIG. 4(b)). A coloring resist liquid 16 is dropped into a concave portion surrounded with the black matrix pattern 6 by a syringe 18, thereby forming a color filter pattern(FIG. 4(c)). Subsequently, a transparent electrode 2(a pixel electrode) is formed not to be superimposed on the surface of the cylinder-shaped resin pattern 17 and to be superimposed on a side of the cylinder-shaped resin pattern 17(FIG. 4(d)), thereby a color filter on-array substrate is obtained.

Recently, a method for forming a color filter by dropping a coloring resist liquid into a concave portion surrounded with the black matrix pattern by a syringe having a fine inner diameter, or injecting fine liquid drops of coloring resist liquid into concave portion in order to reduce the cost of LCD panel is drawing a keen attention.

But, there was a problem that it was difficult to form a contact hole for enabling the switching active element and the pixel electrode to be conductive when forming a LCD panel of a colr filter on TFT array by above method.

Like this embodiment, a conduction between the switching active element 4 and the pixel electrode 2 can be realized by forming a conducting cylinder-shaped resin pattern 17 having conductivity and functioning as a spacer for controlling a panel gap on the drain electrode 12 of a switching element 4 without forming a contact hole. A matrix pattern for preventing a mixed color of adjacent color filter

pattern is formed by an insulating shading resin layer. On the other hand, the pattern shape of the insulating shading resin is designed to be superimposed on the upper side of a conducting cylinder-shaped resin pattern, and thereby prevention of a mixed color of a color filter pattern, prevention of a short between upper and lower substrates when bonding the panels, and shading protection of the switching active transistor 4 can be realized without increasing the process. Therefore, it is possible to produce LCD apparatus of a color filter on TFT array type.

[Embodiment of the Invention]

The first embodiment of the present invention will be explained.

A conducting cylinder-shaped resin pattern(NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the contact hole. At this time, the pattern is designed such that (the diagonal distance of a bottom side of the cylinder-shaped resin pattern) - (the diagonal distance of a surface of the cylinder-shaped resin pattern) is 5μm. Next, a black matrix is used by using a black photo-sensitive resin(CK-S699B, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). Then, a color resist(CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is formed by coating by a spin-coat method, exposing and developing, thereby forming a color filter pattern. At this time,

a blue pattern of a color filter is designed to be imposed on a surface of the cylinder-shaped resin pattern. A pixel ITO electrode pattern is formed by deposition in order not to be superimposed on a surface of the cylinder-shaped resin pattern. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. High-quality display can be realized in which there are no non-uniformity of display and smear.

The second embodiment of the present invention will be explained.

A conducting cylinder-shaped resin pattern(NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the contact hole. At this time, the pattern is designed such that (the diagonal distance of a bottom side of the cylinder-shaped resin pattern) - (the diagonal distance of a surface of the cylinder-shaped resin pattern) is 5μm. Next, a black matrix is used by using a black photo-sensitive resin(CFPR-708 S, Tokyo Ungwha Corp. the volume specific resistance 1.0×1014Ω/m). At this time, a black matrix pattern is designed to be superimposed on a surface of the cylinder-shaped resin pattern. Then, a color

resist(CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is formed by coating by a spin-coat method, exposing and developing, thereby forming a color filter pattern. A pixel ITO electrode pattern is formed by deposition in order not to be superimposed on a surface of the cylinder-shaped resin pattern. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. High-quality display can be realized in which there are no non-uniformity of display and smear.

The third embodiment of the present invention will be explained.

A conducting cylinder-shaped resin pattern with the thickness of 5μm(NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the drain electrode of a TFT array substrate. Next, a black matrix with the thickness 3μm and OD of 3.0 is used by using a black photo-sensitive resin(CK-S699B, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). At this time, a black matrix pattern is designed to be superimposed on a surface of the cylinder-shaped resin pattern and is designed not to be superimposed on the side

of the cylinder-shaped resin pattern. Then, a color resist(CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is dropped into a concave portion surrounded with the black matrix pattern by a syringe, thereby forming a color filter pattern having a thickness of 1μm. A pixel electrode is formed to be superimposed on the surface of the cylinder-shaped resin pattern and not to be superimposed on a side of the cylinder-shaped resin pattern by a deposition. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. High-quality display can be realized in which there are no non-uniformity of display and smear.

The fourth embodiment of the present invention will be explained.

A conducting cylinder-shaped resin pattern with the thickness of 5.3μm(NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the drain electrode of a TFT array substrate. Next, a black matrix with the thickness 0.7μm and OD of of 2.0 is used by using a black photo-sensitive resin(CK-S699B, Whusi Film Allin Corp. the volume specific resistance

1.0×1014Ω/m). At this time, a black matrix pattern is designed to be superimposed on a surface of the cylinder-shaped resin pattern and is designed not to be superimposed on the side of the cylinder-shaped resin pattern. Then, a color resist(CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is dropped into a concave portion surrounded with the black matrix pattern by a syringe, thereby forming a color filter pattern having a thickness of 1μm. A pixel electrode is formed not to be superimposed on the surface of the cylinder-shaped resin pattern and to be superimposed on a side of the cylinder-shaped resin pattern by a deposition. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. High-quality display can be realized in which there are no non-uniformity of display and smear.

The fifth embodiment of the present invention will be explained.

A conducting cylinder-shaped resin pattern with the thickness of 5.0μm(NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the drain electrode of a TFT array substrate. Next, a black matrix

with the thickness 1.0μm and OD of 3.0 is used by using a black photo-sensitive resin (CFPR-708 S, Tokyo Ungwha Corp. the volume specific resistance 1.0×1014Ω/m). At this time, a black matrix pattern is designed to be superimposed on a surface of the cylinder-shaped resin pattern formed in advance and is designed not to be superimposed on the side of the cylinder-shaped resin pattern. Then, a color resist (CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is dropped into a concave portion surrounded with the black matrix pattern by a syringe, thereby forming a color filter pattern having a thickness of 1μm. A pixel electrode ITO is formed not to be superimposed on the surface of the cylinder-shaped resin pattern and to be superimposed on a side of the cylinder-shaped resin pattern by a deposition. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. High-quality display can be realized in which there are no non-uniformity of display and smear.

The sixth embodiment of the present invention will be explained.

A conducting cylinder-shaped resin pattern with the thickness of 5μm(NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the drain electrode of a TFT array substrate. Next, a black matrix with the thickness 1.0μm and OD of 3.0 is used by using a black photo-sensitive resin (CK-S699B, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). At this time, a black matrix pattern is designed to be superimposed on a surface of the cylinder-shaped resin pattern formed in advance and is designed not to be superimposed on the side of the cylinder-shaped resin pattern. Then, a color resist(CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is injected into a concave portion surrounded with the black matrix pattern by a printer head which are being sold in the market, thereby forming a color filter pattern having a thickness of 1μm. A pixel electrode is formed not to be superimposed on the surface of the cylinder-shaped resin pattern and to be superimposed on a side of the cylinder-shaped resin pattern by a deposition. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. High-quality display can be realized in

which there are no non-uniformity of display and smear.

A comparison example 1 of the present invention will be explained.

A conducting cylinder-shaped resin pattern(NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the contact hole. At this time, the pattern is designed such that (the diagonal distance of a bottom side of the cylinder-shaped resin pattern) - (the diagonal distance of a surface of the cylinder-shaped resin pattern) is 5μm. Next, a black matrix is used by using a black photo-sensitive resin(CK-S171C, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). At this time, a black matrix is designed to be imposed on a surface of the cylinder-shaped resin pattern. Then, a color resist(CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is formed by coating by a spin-coat method, exposing and developing, thereby forming a color filter pattern. A pixel ITO electrode pattern is formed by deposition in order not to be superimposed on a surface of the cylinder-shaped resin pattern. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is

observed by human eyes. Non-uniformity of display and light leakage are generated due to a short between upper and lower substrates.

A comparison example 2 of the present invention will be explained.

A conducting cylinder-shaped resin pattern (NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the contact hole. At this time, the pattern is designed such that (the diagonal distance of a bottom side of the cylinder-shaped resin pattern) - (the diagonal distance of a surface of the cylinder-shaped resin pattern) is 4μm. Next, a black matrix is used by using a black photo-sensitive resin (CK699B, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). Then, a color resist (CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is formed by coating by a spin-coat method, exposing and developing, thereby forming a color filter pattern. At this time, a blue pattern is designed to be superimposed on a surface of the cylinder-shaped resin pattern. A pixel ITO electrode pattern is formed by deposition in order not to be superimposed on a surface of the cylinder-shaped resin pattern. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal

panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. A number of smears can be found due to a contact defect of a pixel electrode.

A comparison example 3 of the present invention will be explained. A conducting cylinder-shaped resin pattern with the thickness of 5μm (NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the contact hole. At this time, the pattern is designed such that (the diagonal distance of a bottom side of the cylinder-shaped resin pattern) - (the diagonal distance of a surface of the cylinder-shaped resin pattern) is 5μm. Next, a black matrix is used by using a black photo-sensitive resin (CK699B, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). Then, a color resist (CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is formed by coating by a spin-coat method, exposing and developing, thereby forming a color filter pattern. At this time, a black matrix pattern and a color filter pattern are designed not to be superimposed on a surface of the cylinder-shaped resin pattern. A pixel ITO electrode pattern is formed by deposition in order not to be superimposed on a surface of the cylinder-shaped resin pattern. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant

cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. Non-uniformity of display and light leakage are generated due to a short between upper and lower substrates.

A comparison example 4 of the present invention will be explained. A conducting cylinder-shaped resin pattern with the thickness of 2μm (NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the drain electrode of a TFT array substrate. Next, a black matrix having a thickness of 3.0μm and OD<4.0 is used by using a black photo-sensitive resin (CK699B, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). At this time, a black matrix pattern and a color filter pattern are designed to be superimposed on a surface of the cylinder-shaped resin pattern formed in advance, and designed not to be superimposed on a side of the cylinder-shaped resin pattern. Then, a color resist (CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is dropped into a concave portion surrounded with the black matrix pattern by a syringe, thereby forming a color filter pattern having a thickness of 1μm. A pixel ITO electrode pattern is formed by deposition in order not to be superimposed on a surface of the cylinder-shaped resin pattern, and to be superimposed on a side of the cylinder-shaped resin pattern. Further, after an orientation layer pattern is formed and the orientation process is performed by

rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. In the produced liquid crystal panel, since a drain electrode and a pixel electrode are not conducting due to coloring resist remaining layer which is attached on the side of the resin layer, lighting can not be realized.

A compariosn example 5 of the present invention will be explained.

A conducting cylinder-shaped resin pattern with the thickness of 5.4μm (NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the drain electrode of a TFT array substrate. Next, a black matrix with the thickness 0.6μm and OD of 1.8 is formed by using a black photo-sensitive resin (CK-S699B, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). At this time, a black matrix pattern is designed to be superimposed on a surface of the cylinder-shaped resin pattern formed in advance and is designed not to be superimposed on the side of the cylinder-shaped resin pattern. Then, a color resist (CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is dropped into a concave portion surrounded with the black matrix pattern by a syringe, thereby forming a color filter pattern having a

thickness of 1μm. A pixel ITO electrode pattern is formed not to be superimposed on the surface of the cylinder-shaped resin pattern and to be superimposed on a side of the cylinder-shaped resin pattern by a deposition. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. A deterioration of contrast property generated due to the light leakage in case of "off" display can be observed.

A comparison example 6 of the present invention will be explained.

A conducting cylinder-shaped resin pattern with the thickness of 5.4μm (NN700, JSR Corp. a conducting silver filler is added) for forming a panel gap is formed on the drain electrode of a TFT array substrate. Next, a black matrix with the thickness 1.0μm and OD of 3.0 is formed by using a black photo-sensitive resin (CK-S171C, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m). At this time, a black matrix pattern is designed to be superimposed on a surface of the cylinder-shaped resin pattern formed in advance and is designed not to be superimposed on the side of the cylinder-shaped resin

pattern. Then, a color resist (CM7000, Whusi Film Allin Corp. the volume specific resistance 1.0×1014Ω/m) is dropped into a concave portion surrounded with the black matrix pattern by a syringe, thereby forming a color filter pattern having a thickness of 1μm. A pixel ITO electrode pattern is formed not to be superimposed on the surface of the cylinder-shaped resin pattern and to be superimposed on a side of the cylinder-shaped resin pattern by a deposition. Further, after an orientation layer pattern is formed and the orientation process is performed by rubbing, a vacant cell is formed by bonding the opposing color filter substrate for which same orientation process is performed with the seal resin. After injecting liquid crystal into the vacant cell by a vacuum injection method, a liquid crystal panel is formed by sealing the inlet. The non-uniformity of the liquid crystal panel is observed by human eyes. A high-quality display can not be realized due to a short between the electrodes.

Further, the present invention can be applied to a LCD apparatus of TN type and IPS type. In addition, an orientation process is performed by optical orientation (rubbingless : orientation is not performed by a mechanical means).

Further, if theres are lots of spacers of the cylinder-shaped resin pattern(per unit space), low-temperature foams are generated, and if not, there is a problem in terms of a display performance because of a gap change created due to

temperature change. Therefore, in connection with the number of a spacer of the cylinder-shaped resin pattern, optimum value is set according to a liquid crystal material, a spacer material or structure of a liquid crystal panel. It is designed such that the optimum value can be found through an experiment or a simulation.

Further, an image display application device can be formed by using a LCD apparatus having above-mentioned structure.

[Effect of the Invention]

According to a LCD apparatus described in the claim 1 of the present invention, a cylinder-shaped resin pattern for forming the panel gap is formed on the contact hole as a resin having conductivity, a surface of the cylinder-shaped resin pattern is coated by insulating, and the pixel electrode is formed in the vicinity of the cylinder-shaped resin pattern. Therefore, it is possible to form a pixel electrode after forming a cylinder-shaped resin pattern having conductivity around the contact hole. Consequently, the adhesion of the cylinder-shaped resin pattern is improved by preventing peeling off of the cylinder-shaped resin pattern, the contact problems between a switching active element and a pixel electrode are reduced, surface faulting of a substrate is reduced and disturbance of liquid crystal orientation due to faulting is prevented. Because of those effects, a high-quality display having no non-uniformity can be realized.

In the claim 2, since a surface of the cylinder-shaped resin pattern is coated by insulating, thereby insulating the opposing electrode, it is possible to suppress the short problems between upper and lower substrates when a panel bonding by covering the surface of the cylinder-shaped resin pattern having conductivity with a resin layer having no conductivity.

In the claim 3, since the resin layer is a color filter pattern, and a surface of the cylinder-shaped resin pattern is covered with a plurality of color layers of monochrome for forming a color filter pattern, it is possible to exhibit more excellent display performances without the short problems between upper and lower substrates.

In the claim 4, since the lower limit of volume specific resistance value for forming the color filter pattern is 108Ω/cm, it is possible to exhibit more excellent display performances without the short problems between upper and lower substrates.

In the claim 5, since the pixel electrode is not superimposed on the surface of the cylinder-shaped resin pattern and is superimposed on the side of the cylinder-shaped resin pattern, it is possible to make the switching active element and the pixel electrode to be in conduction state without the short problems between upper and lower substrates.

In the claim 6, since the lower limit of (the diameter of bottom side of the cylinder-shaped resin pattern, or distance of diagonal line) - (the diameter of a surface of the cylinder-shaped resin pattern, or distance of diagonal line) is 5 μm, it enables the switching active element and the pixel electrode to be in conduction state.

In the claim 7, an orientation process performed by optical orientation can be applied to LCD apparatus,

According to the manufacturing method of LCD apparatus described in the claim 8, since a panel gap between the TFT array substrate and an opposing facing the TFT array substrate is formed as a resin having conductivity on the contact hole formed on the resin layer, a surface of the cylinder-shaped resin pattern is coated by insulating, a pixel electrode is formed, and the switching active element and the pixel electrode are contacted with the cylinder-shaped resin pattern is sandwiched therebetween, the cylinder-shaped resin pattern can prevents peeling off. Adhesion of the substrates is improved, the contact problems between a switching active element and a pixel electrode are reduced, surface faulting of a substrate is reduced and disturbance of liquid crystal orientation due to faulting is prevented. In addition, it is possible to suppress the short problems between upper and lower substrates when a panel bonding by covering the surface of the cylinder-shaped

resin pattern having conductivity with a resin layer having no conductivity.

According to a manufacturing method of a LCD apparatus described in the claim 9, a conduction between the switching active element and the pixel electrode can be realized by forming a conducting cylinder-shaped resin pattern having conductivity and functioning as a spacer for controlling on the drain electrode of a switching element. A matrix pattern for preventing a mixed color of adjacent color filter pattern is formed by an insulating shading resin layer. On the other hand, the pattern shape of the insulating shading resin is designed to be superimposed on the upper side of a conducting cylinder-shaped resin pattern, and thereby prevention of a mixed color of a color filter pattern, prevention of a short between upper and lower substrates when bonding the panels, and shading protection of the switching active transistor can be realized. Therefore, it is possible to produce LCD apparatus of a color filter on TFT array type.

In the claim 10, since the supplying method of coloring resist liquid is dropping method by a syringe, it is possible to form a color filter on a TFT array substrate with high efficiency.

In the claim 11, since the supplying method of coloring resist liquid is an injection by liquid dropping, it is possible to form a color filter on a TFT array substrate with high efficiency. In addition, In injection of coloring resist liquid

dropping, a printer head can be used.

In the claim 12, since the relationship, (the layer thickness of an insulating shading cylinder-shaped resin pattern) < (the layer thickness of the cylinder-shaped resin pattern) is satisfied, it is possible to contact the switching active element and the pixel electrode.

In the claim 13, since the insulating shading cylinder-shaped resin pattern covers the switching active element on the TFT array substrate, a shading protection of a transistor can be realized.

In the claim 14, since the lower limit of volume specific resistance value of the insulating shading cylinder-shaped resin pattern is 108Ω/cm, the short problems between the electrodes can be prevented.

In the claim 15, since the lower limit of OD value of the insulating shading cylinder-shaped resin pattern is above 2.0, shading protection of a transistor can be realized. OD value is an abbreviation of optical density, and can be also called as optical concentration. That is, it means the transmissivity of light against a black portion such as a black matrix. As the value is getting larger and larger, the light can not penetrate.

In the claim 16, since the pixel electrode is not superimposed on the surface of the cylinder-shaped resin pattern and is superimposed on the side of the

cylinder-shaped resin pattern, a short problem between opposing substrates can be prevented.

According to an image display application device set forth in the claim 17, since a LCD apparatus including the structure described as above is provided, the LCD apparatus is suitable for an image display application device which requirs a liquid crystal panel having high brightness, high precision and uniformity of display.

[Description of Drawings]

FIG. 1 is a cross-section of a LCD apparatus according to the first embodiment of the present invention.

FIG. 2(a) is a plane drawing of a cylinder-shaped resin pattern, 2(b) is a cross-sectional drawing.

FIG. 3 is a cross-section of a LCD apparatus according to the second embodiment of the present invention.

FIG. 4 is a process flow of manufacturing method of a LCD apparatus according to the second embodiment of the present invention.

FIG. 5 is a cross-section of a conventional LCD apparatus.